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(56) Documents Cited

US 5733095 A

US 5513491 A

US 5195864 A

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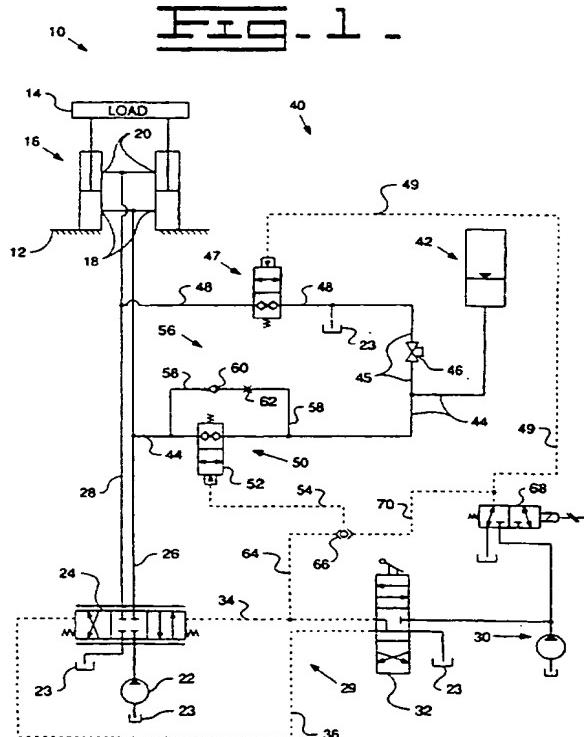
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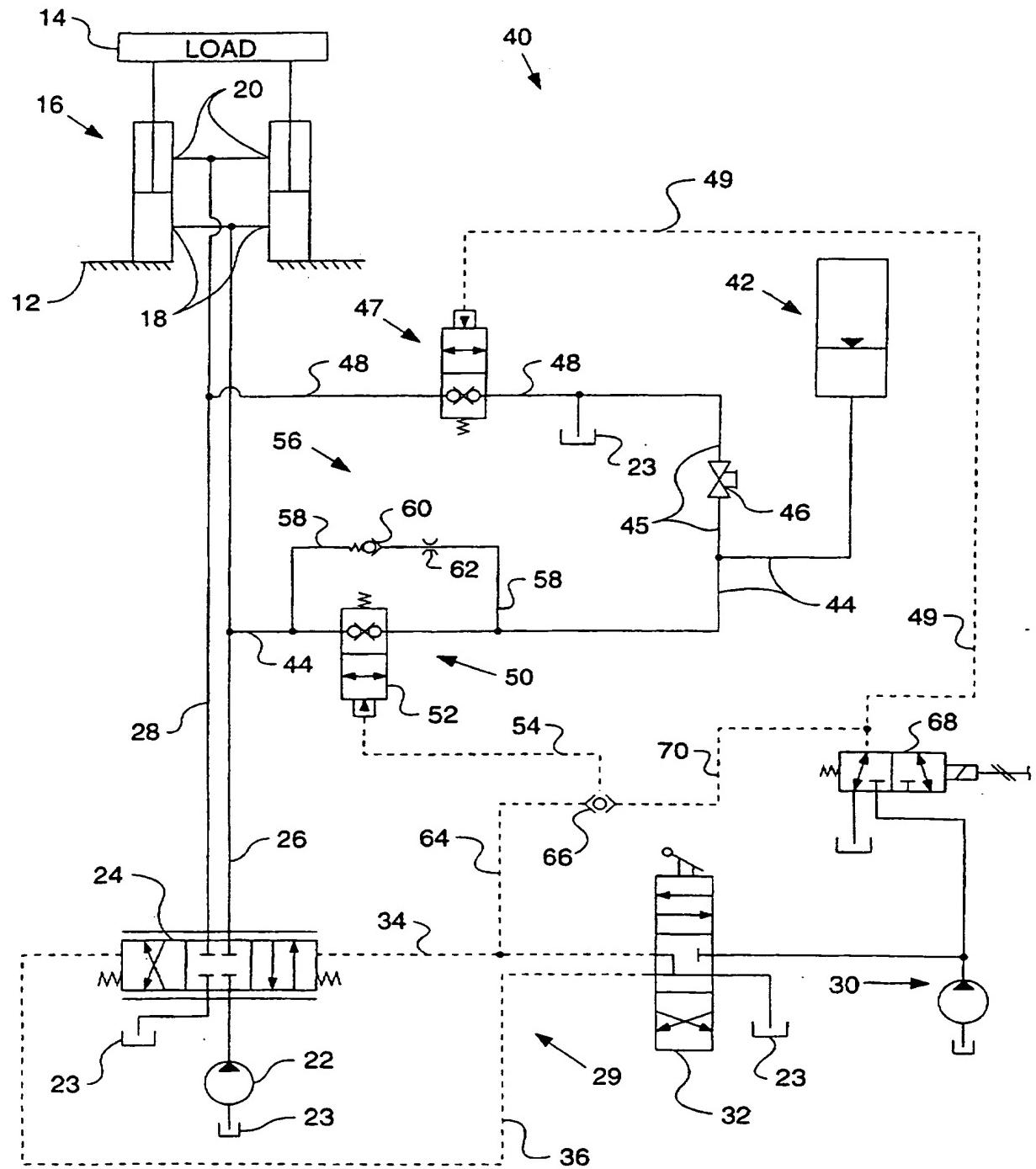
Hydraulic ride control system

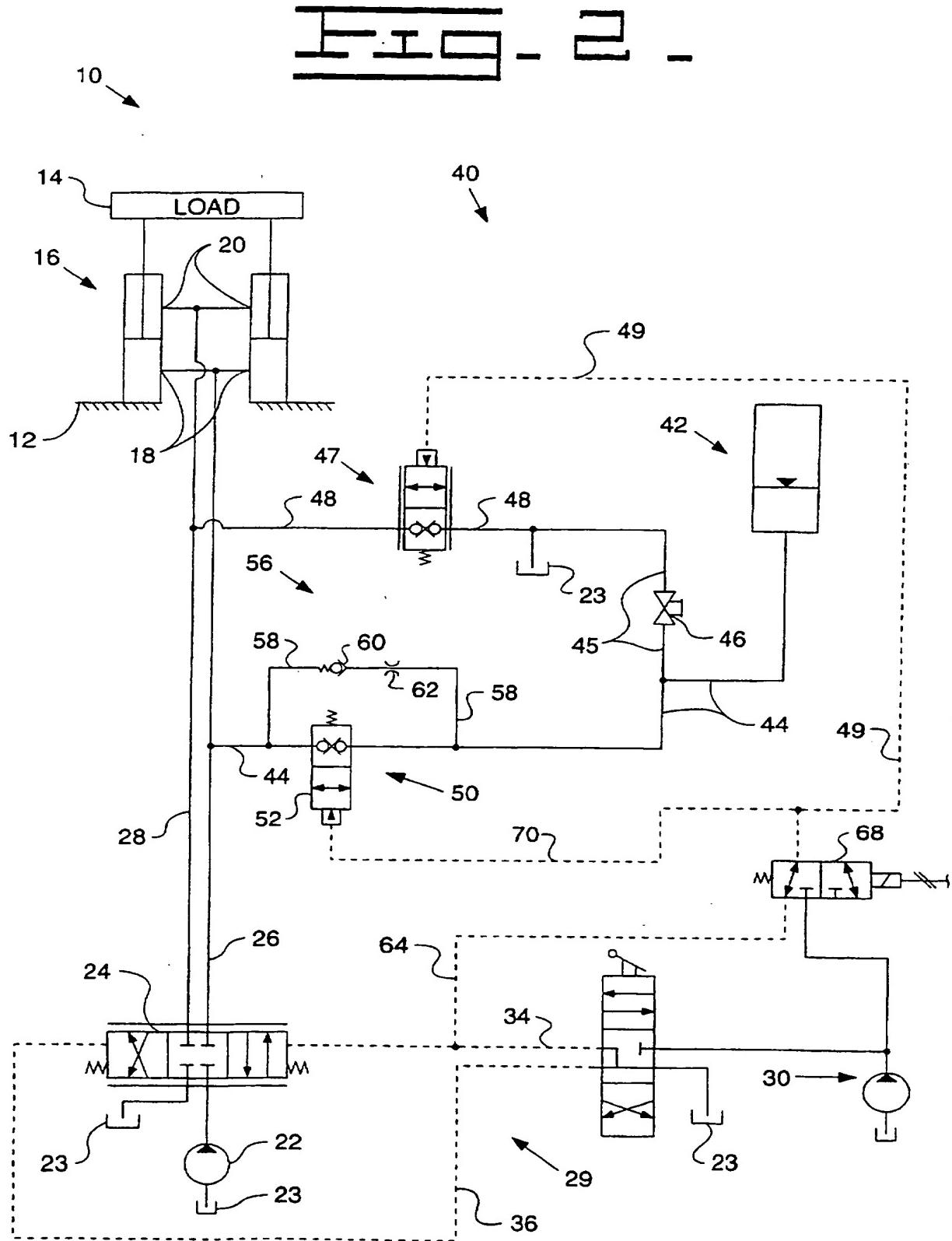
(57) A hydraulic ride control system (40) is disclosed and adapted to control the ride of a machine having a load (14). The ride control (40) includes an accumulator arrangement (42) that is selectively connected with the actuator (16) that is carrying the load (14) to provide a cushion ride during travelling and to enable the pressure in the accumulator arrangement (42) to be maintained substantially the same as the pressure in the actuator (16) when raising the load (14) and to permit the pressure in the accumulator arrangement (42) to be lowered to that of the pressure in the actuator (16) in the event the load (14) is lessened. The ride control system (40) also provides an arrangement that permits the accumulator arrangement (42) to be bled down whenever the machine becomes disabled or when the machine is shut off.

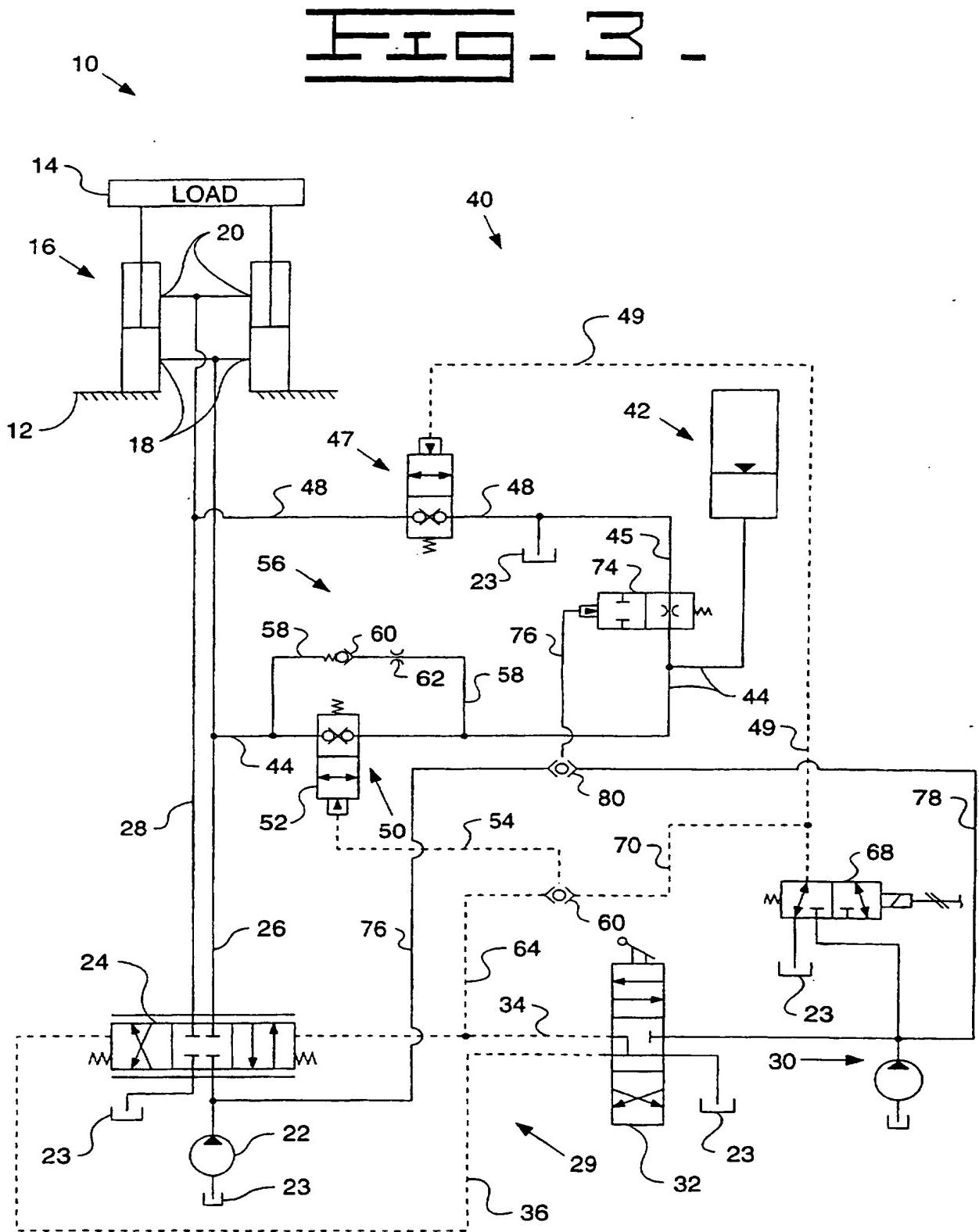


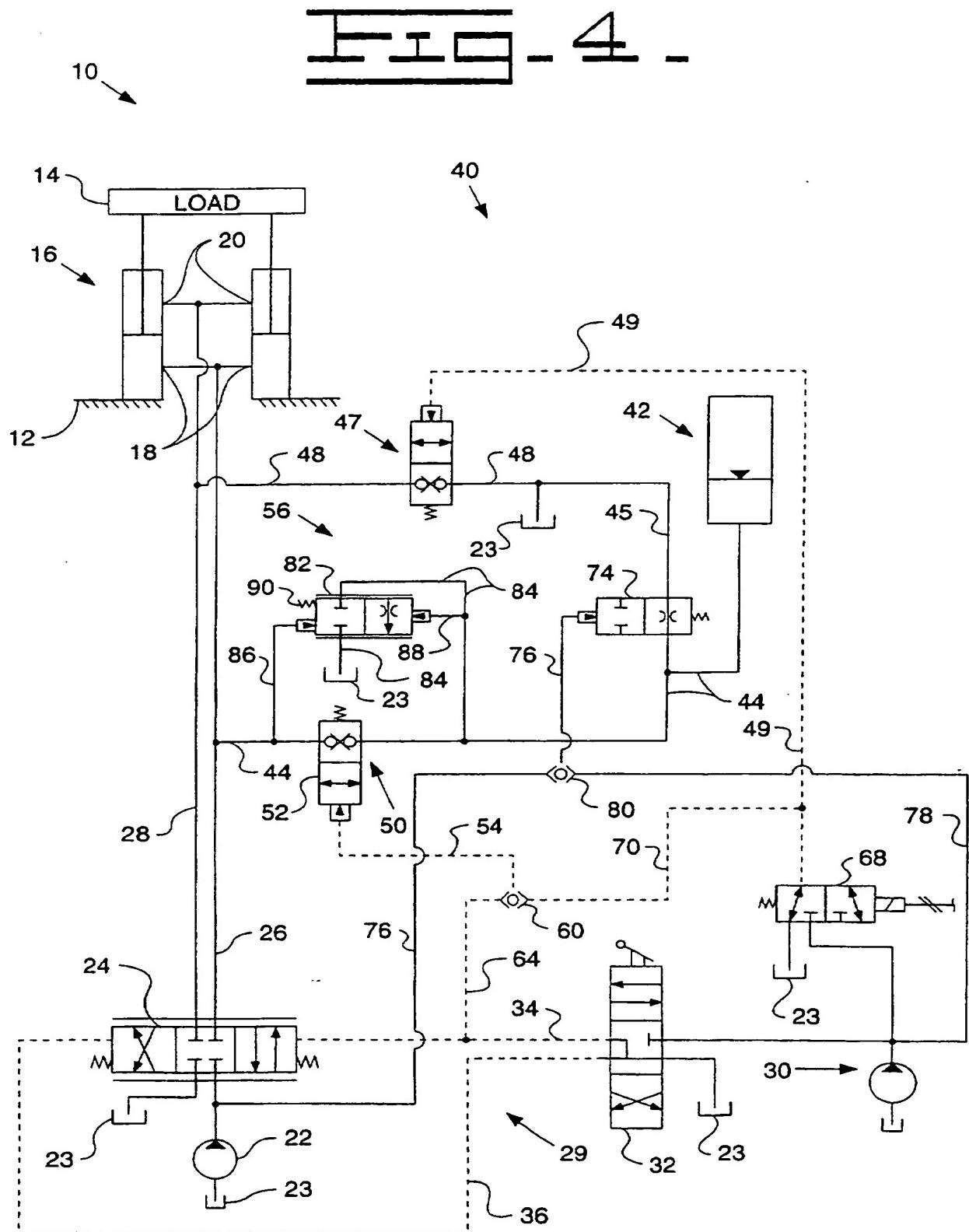
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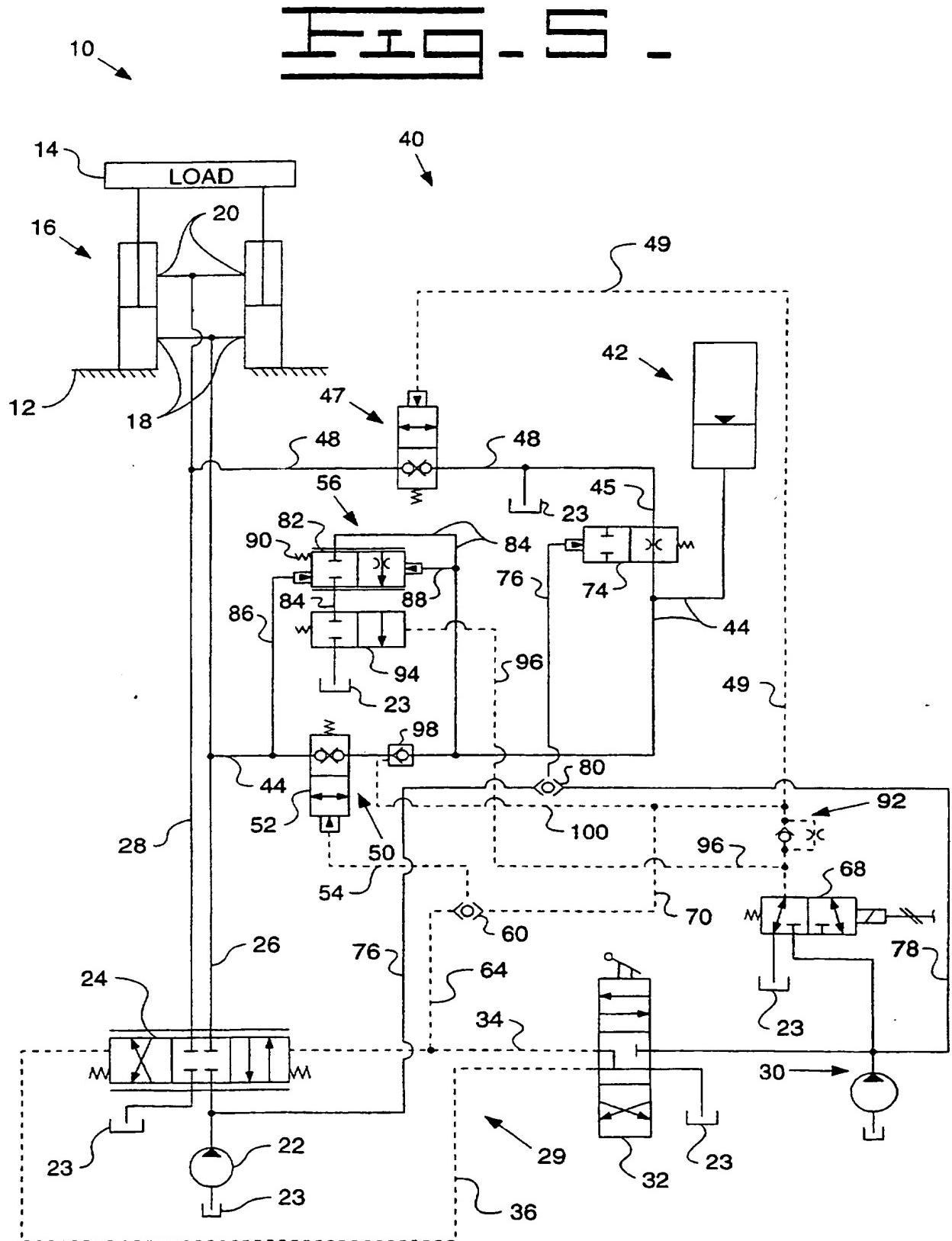
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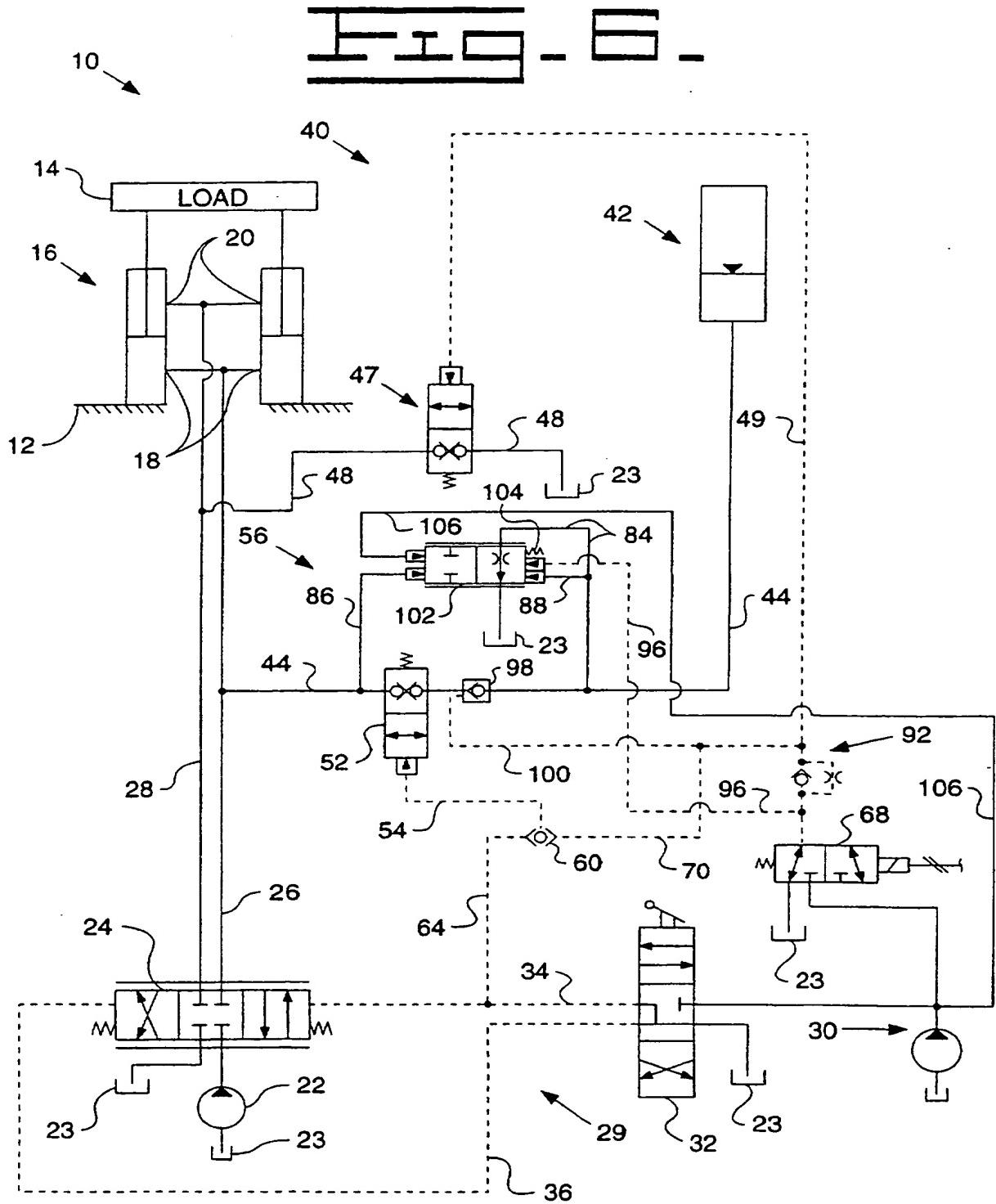












1                   Description

2

3                   HYDRAULIC RIDE CONTROL SYSTEM

4

5                   Technical Field

6                   This invention relates generally to a ride  
7                   control system for a machine and more particularly to  
8                   a control system for selectively providing a  
9                   cushioned ride control.

10

11                  Background Art

12                  In known ride control systems for machines,  
13                  cushioning of the ride is controlled by an  
14                  accumulator or accumulators connected in parallel.  
15                  In such machines having a bucket or such on the front  
16                  or back thereof, there is a possibility that the  
17                  machine will lop or bounce due to the weight of the  
18                  bucket reacting to the machine traveling over rough  
19                  terrain or other obstacles. It is desirable to  
20                  selectively activate the ride control and not permit

1       the bucket to have any degree of movement from its  
2       initial position and to permit any pressure in the  
3       accumulator to be bled down when the machine is shut  
4       down. Known ride control systems are often complex  
5       and give the actuators/cylinders a spongy feeling.

6                  The present invention is directed to  
7       overcoming one or more of the problems as set forth  
8       above.

9

10       Disclosure of the Invention

11                  According to a first aspect of the present  
12       invention there is provided a hydraulic ride control  
13       system in accordance with Claim 1.

14                  In the first aspect of the present  
15       invention a hydraulic ride control system is provided  
16       and adapted for use in a fluid system of a machine to  
17       cushion the ride of the machine in response to  
18       initiation of a ride control mode command. The  
19       machine includes a frame with an actuator arrangement  
20       disposed between the frame and a load to raise and  
21       lower the load relative to the frame. The actuator  
22       arrangement has a raise port and a lower port and is  
23       operative upon initiation of a raise mode command to  
24       raise the load to a desired height in response to  
25       pressurized fluid being selectively directed to the  
26       raise port from a source of pressurized fluid and to  
27       exhaust fluid from the lower port to a reservoir in  
28       response to initiation of a lower mode command. The  
29       hydraulic ride control system includes an accumulator  
30       arrangement connectable to the raise port of the  
31       actuator arrangement, a first valve arrangement and a

1 second valve arrangement. The first valve  
2 arrangement is connectable between the lower port of  
3 the actuator arrangement and the reservoir and  
4 operative to selectively connect the lower port to  
5 the reservoir in response to initiation of a ride  
6 control mode command. The second valve arrangement  
7 is disposed between the accumulator arrangement and  
8 the raise port of the actuator arrangement and  
9 operative to selectively connect the accumulator  
10 arrangement to the raise port of the actuator  
11 arrangement in response to one of the initiation of  
12 the raise mode command and the initiation of a ride  
13 control mode command.

14

15 Brief Description of the Drawings

16 Fig. 1 is a schematic representation of a  
17 ride control system of a machine incorporating an  
18 embodiment of the subject invention;

19 Fig. 2 is a schematic representation of a  
20 ride control system of a machine incorporating  
21 another embodiment of the subject invention;

22 Fig. 3 is a schematic representation of a  
23 ride control system of a machine incorporating yet  
24 another embodiment of the subject invention;

25 Fig. 4 is a schematic representation of a  
26 ride control system of a machine incorporating yet  
27 another embodiment of the subject invention;

28 Fig. 5 is a schematic representation of a  
29 ride control system of a machine incorporating yet  
30 another embodiment of the subject invention; and

1                   Fig. 6 is a schematic representation of a  
2 ride control system of a machine incorporating yet  
3 another embodiment of the subject invention.  
4

5                   Best Mode for Carrying Out the Invention

6                   Referring to the drawings, and more  
7 particularly to Fig. 1, a fluid system 10 is  
8 illustrated and adapted for use in a machine (not  
9 shown) to control the riding comfort of the machine.  
10 A frame 12 and a load (bucket) 14 is diagrammatically  
11 illustrated in combination with the fluid system 10.

12                  The fluid system 10 includes an actuator  
13 arrangement 16 disposed between the frame 12 and the  
14 load 14. The actuator arrangement 16 has a raise  
15 port 18 and a lower port 20. In the subject  
16 embodiment, two hydraulic cylinders are shown but it  
17 is recognized that only one or more than two  
18 cylinders could be used. A source of pressurized  
19 fluid, such as a pump 22, receives fluid from a  
20 reservoir 23 and provides pressurized fluid through a  
21 directional control valve 24 to the actuator  
22 arrangement 16 in a conventional manner to  
23 controllably raise and lower the load. Conduits  
24 26,28 direct the fluid flow between the directional  
25 control valve 24 and the raise and lower ports 18,20  
26 of the actuator arrangement 16. In the subject  
27 embodiment, the movement of the directional control  
28 valve 24 is controlled by a pilot system 29. The  
29 pilot system 29 includes a source of pressurized  
30 pilot fluid 30 which directs a raise mode command and

1 a lower mode command to the directional control valve  
2 24 through respective pilot conduits 34,36.

3 A hydraulic ride control system 40 is  
4 provided and includes an accumulator arrangement 42  
5 connected to the raise port 18 of the fluid actuator  
6 arrangement 16 through a conduit 44. The accumulator  
7 arrangement 42 is selectively connected to the  
8 reservoir 23 through a conduit 45 having a manually  
9 operated shutoff valve 46 disposed therein.

10 A first valve arrangement 47 is disposed in  
11 a conduit 48 between the lower port 20 of the  
12 actuator arrangement 16 and the reservoir 23. The  
13 first valve arrangement 47 is mechanically biased to  
14 a flow blocking position and movable to a flow  
15 passing position in response to receipt of a signal  
16 through a signal conduit 49 that is representing  
17 initiation of a ride control mode command.

18 A second valve arrangement 50 is provided  
19 and disposed in the conduit 44 between the raise port  
20 18 and the accumulator arrangement 42. The second  
21 valve arrangement 50 includes a two position valve 52  
22 that is mechanically biased to a flow blocking  
23 position and movable to a flow passing position in  
24 response to receipt of a command signal thereto  
25 through a conduit 54.

26 The second valve arrangement 50 also  
27 includes a flow restriction mechanism 56 disposed in  
28 a conduit 58 between the raise port 18 and the  
29 accumulator arrangement 42 in parallel with the two  
30 position valve 52. The flow restriction mechanism 56  
31 of the subject embodiment includes a one-way check

1 valve 60 disposed in the conduit 58 and is operative  
2 to permit flow from the accumulator arrangement 42 to  
3 the raise port 18 and prohibit reverse flow  
4 therethrough from the raise port 18 to the  
5 accumulator arrangement 42. A damping orifice 62 is  
6 also disposed adjacent the one-way check valve in the  
7 conduit 58 between the one-way check valve 60 and the  
8 accumulator arrangement 42.

9 The raise mode command is produced by  
10 controllably connecting the source of pressurized  
11 fluid 30 to the conduit 34 via a shifted valve 32.  
12 The pressure signal which represents the raise mode  
13 command is directed through a conduit 64, a resolver  
14 valve 66 and the signal conduit 54 to the two  
15 position valve 52.

16 The ride control mode command is produced  
17 by receiving a pressure signal from the source of  
18 pressurized pilot fluid 30 through an electrically  
19 actuated two position switching valve 68 to the  
20 signal conduit 49. The electrically actuated two  
21 position switching valve 68 is mechanically biased to  
22 a first position at which the source of pressurized  
23 pilot fluid 30 is blocked from the signal conduit 49  
24 and the signal conduit 49 is open to the reservoir 23  
25 and a second position at which the source of  
26 pressurized pilot fluid 30 is in communication with  
27 the signal conduit 49 and the signal conduit 49 is  
28 blocked from the reservoir 23. The ride control mode  
29 command is also directed to the two position valve 52  
30 of the second valve arrangement 50 through a conduit  
31 70, the resolver 66 and the conduit 54.

1 Referring to Fig. 2 another embodiment of  
2 the subject invention is illustrated. Like elements  
3 have like element numbers. In the embodiment of Fig.  
4 2, the first valve arrangement 47 is a two position  
5 valve that is proportionally moved from a flow  
6 blocking position towards a flow passing position in  
7 response to the ride control mode command as directed  
8 through the signal conduit 49.

9 In the mechanically biased position of the  
10 electrically actuated two position switching valve  
11 68, the raise mode command is communicated through  
12 the conduit 64 across the electrically actuated two  
13 position switching valve 68 to the signal conduit 49  
14 instead of the signal conduit 49 being connected to  
15 the reservoir 23 as set forth with respect to Fig. 1.

16 Referring to Fig. 3, another embodiment of  
17 the present invention is disclosed. Like elements  
18 have like element numbers. The embodiment of Fig. 3  
19 is very similar to that of Fig. 1. The only  
20 difference is that the manually operated shutoff  
21 valve 46 disposed between the accumulator arrangement  
22 and the reservoir 23 is replaced with a two  
23 position bypass valve 74. The two position bypass  
24 valve 74 is mechanically biased to a flow passing  
25 position and movable to a flow blocking position in  
26 response to the source of pressurized fluid 22 or in  
27 response to the source of pressurized pilot fluid 30.  
28 A conduit 76 connects the source of pressurized fluid  
29 22 to the two position bypass valve 74. The source  
30 of pressurized pilot fluid 30 is connected to the two

1 position bypass valve 74 through a conduit 78, a  
2 resolver valve 80 and a portion of the conduit 76.

3 Referring to Fig. 4, another embodiment of  
4 the subject invention is disclosed. Like elements  
5 have like element numbers. The embodiment of Fig. 4  
6 is very similar to Fig. 3. The difference  
7 therebetween is that the flow restriction mechanism  
8 56 of Fig. 4 is different. The flow restriction  
9 mechanism 56 of Fig. 4 includes a proportionally  
10 controlled two position valve 82 disposed in a  
11 conduit 84 between the accumulator arrangement 42 and  
12 the reservoir 23 and is responsive to the  
13 relationship between the pressures of fluid in the  
14 raise port 18 of the actuator arrangement 16 and the  
15 accumulator arrangement 42 through respective  
16 conduits 86,88. The proportionally controlled two  
17 position valve 82 is mechanically biased to a first  
18 position by a spring 90 and by the pressure from the  
19 raise end port 18 at which the conduit 84 from the  
20 accumulator arrangement 42 is blocked from the  
21 reservoir 23 and movable towards a second position by  
22 the pressure in the accumulator arrangement 42 at  
23 which the conduit 84 from the accumulator arrangement  
24 42 is in communication with the reservoir 23.

25 Referring to Fig. 5, another embodiment of  
26 the subject invention is disclosed. Like elements  
27 have like element numbers. The embodiment of Fig. 5  
28 is very similar to that of Fig. 4. One of the  
29 differences is that in the embodiment of Fig. 5, a  
30 choke and check valve arrangement 92 is disposed in  
31 the signal conduit 49 between the electrically

1 actuated two position switching valve 68 and the  
2 first and second valve arrangements 47,50. The choke  
3 and check valve arrangement 92 operates in a  
4 conventional manner to permit free flow of fluid in  
5 the signal conduit 49 from the first and second valve  
6 arrangements 47,50 to the electrically actuated two  
7 position switching valve 68 and to choke/restrict the  
8 rate of flow from the electrically actuated two  
9 position switching valve 68 to the first and second  
10 valve arrangements 47,50.

11 Another difference is that a two position  
12 blocker valve 94 is disposed in the conduit 84  
13 between the proportionally controlled two position  
14 valve 82 and the reservoir 23. The two position  
15 blocker valve 94 is mechanically biased to a flow  
16 blocking position and movable to a flow passing  
17 position in response to receipt of the ride control  
18 mode command delivered thereto through a signal  
19 conduit 96 that is connected to the signal conduit 49  
20 between the electrically actuated two position  
21 switching valve 68 and the choke and check valve  
22 arrangement 92.

23 Additionally, a pilot operated check valve  
24 98 is disposed in the conduit 44 generally adjacent  
25 the two position valve 52 of the second valve  
26 arrangement 50. The pilot operated check valve 98 is  
27 operative to block the flow of fluid from the  
28 accumulator arrangement 42 to the two position valve  
29 52 in the absence of a ride control mode command and  
30 is moved to a flow passing position in response to  
31 receipt of the ride control mode command through a

1 conduit 100 that is connected to the signal conduit  
2 49 between the choke and check valve arrangement 92  
3 and the first and second valve arrangements 47,50.

4 Referring to Fig. 6, another embodiment of  
5 the subject invention is disclosed. Like elements  
6 have like element numbers. The embodiment of Fig. 6  
7 is very similar to the embodiment of Fig. 5. In the  
8 embodiment of Fig. 6 the two position bypass valve 74  
9 and the conduit 45 connecting the accumulator  
10 arrangement 42 with the reservoir have been removed  
11 along with the conduits 76,78 and associated resolver  
12 valve 80.

13 Additionally, the flow restriction  
14 mechanism 56 is different. The flow restriction  
15 mechanism 56 of Fig. 6 includes a single proportional  
16 valve 102 that replaces the proportionally controlled  
17 two position valve 82, the two position blocker valve  
18 94, the bypass valve 74 and the conduit 45. The  
19 single proportional valve 102 is movable between a  
20 first position at which the accumulator arrangement  
21 42 is in communication with the reservoir 23 and a  
22 second position at which the accumulator arrangement  
23 42 is blocked from the reservoir 23. The single  
24 proportional valve 102 is mechanically biased to its  
25 first position by a spring 104, the pressure of the  
26 fluid in the accumulator arrangement 42 delivered  
27 through the conduit 88 and the ride control mode  
28 command as delivered through the conduit 96. The  
29 single proportional valve 102 is movable towards its  
30 second position in response to the pressure of the  
31 source of pressurized pilot fluid 30 as delivered

1 through conduit 106 and the pressure in the raise  
2 port 18 of the actuator arrangement 16 as delivered  
3 through the conduit 86.

4 It is recognized that various other  
5 embodiments and combinations of the embodiments of  
6 Figs 1-6 could be used without departing from the  
7 essence of the subject invention. For example, the  
8 first valve arrangement 47 of Figs. 1,3-6 could be a  
9 pilot operated check valve as opposed to the two  
10 position valve set forth and described. It is also  
11 recognized that the first valve arrangement 47, the  
12 two position valve 52 of the second valve arrangement  
13 50, the two position bypass valve 74, the  
14 proportionally controlled two position valve 82 and  
15 the two position blocker valve 94 of the flow  
16 restriction mechanism 56 could be controlled  
17 electrically by using pressure sensors to monitor  
18 operating pressures at various locations within the  
19 fluid system and delivering the sensed pressures to  
20 an electronic controller which in turn would control  
21 opening and closing the respective valves  
22 accordingly.

23

24 Industrial Applicability

25 During normal operation of the fluid system  
26 as set forth in Fig. 1, the load 14 is raised and  
27 lowered in response to an input to the pilot control  
28 valve 32. The raise mode command is established by  
29 moving the pilot control valve 32 to the position to  
30 direct pressurized pilot fluid through the pilot  
31 conduit 34 to the directional control valve 24. The

1 directional control valve in turn moves towards its  
2 operative raise position which directs pressurized  
3 fluid from the pump 22 to the raise ports 18 of the  
4 actuator arrangement 16. Fluid being exhausted from  
5 the lower ports 20 is directed across the directional  
6 control valve 24 to the reservoir 23. During normal  
7 raising and lowering of the load 14, fluid flow from  
8 the lower ports 20 of the actuator arrangement 16  
9 through the first valve arrangement 47 to the  
10 reservoir 23 is blocked since the first valve  
11 arrangement 47 is in its flow blocking position. At  
12 the same time, fluid flow from the raise ports 18 to  
13 the accumulator arrangement 42 is permitted to pass  
14 through the two position valve 52 of the second valve  
15 arrangement 50. The two position valve 52 is moved  
16 to its flow passing position since the raise mode  
17 command is directed thereto through the conduits  
18 64,54. Consequently, the pressure in the accumulator  
19 arrangement 42 is continuously maintained the same as  
20 the pressure of the load as measured at the load  
21 ports 18 during the raise mode.

22 When it is desirable to raise a load and  
23 carry it for a distance, the load is raised to a  
24 desired height and the directional control valve 24  
25 is returned to the position illustrated in Fig. 1.  
26 At this point the two position valve 52 returns to  
27 its flow blocking position. In order to initiate the  
28 hydraulic ride control system 40, an electrical  
29 signal is directed to the two position switching  
30 valve 68 moving it to the position to connect the  
31 source of pressurized pilot fluid 30 to the signal

1 conduit 49 thus initiating the ride control mode  
2 command. The ride control mode command is directed  
3 simultaneously to the first valve arrangement 47 and  
4 the two position valve 52 of the second valve  
5 arrangement 50 moving each of them to their  
6 respective flow passing positions.

7 With the first valve arrangement 47 in its  
8 flow passing position, flow is free to travel  
9 therethrough between the lower ports 20 and the  
10 reservoir 23. Likewise, flow is free to pass between  
11 the accumulator arrangement 42 and the raise ports 18  
12 across the two position valve 52. Since the  
13 accumulator arrangement 42 was pre-charged during the  
14 raise mode, there is no movement of the load as the  
15 two position valve 52 moves to its open position to  
16 connect the raise ports therewith. As the machine  
17 travels along its path, the accumulator arrangement  
18 42 absorbs any bouncing or shocks induced by the load  
19 so that the machine is not subjected to sudden shocks  
20 or bouncing.

21 When the ride control mode is de-activated,  
22 the two position valve 68 returns to its mechanically  
23 biased position which vents the signal conduit 49 to  
24 the reservoir 23. As a result thereof, the first  
25 valve arrangement 47 and the two position valve 52  
26 return to their respective flow blocking positions.  
27 If the load is lightened by, for example, a portion  
28 of the load being dumped, the pressure in the raise  
29 ports 18 is proportionally reduced. Once the  
30 pressure in the raise ports 18 lessens, the higher  
31 pressure in the accumulator arrangement 42 is lowered

1 to match the pressure in the raise ports 18 by  
2 bleeding down through the orifice 62 and the one way  
3 check valve 60. Therefore, in the event it is  
4 desirable to subsequently activate the ride control,  
5 there is not sudden movement of the load since the  
6 pressure of the load is substantially the same as the  
7 pressure in the accumulator arrangement 42.

8 In the event the machine becomes disabled  
9 with the accumulator arrangement 42 charged to a high  
10 level, the pressure in the accumulator arrangement 42  
11 can be bleed down by opening the manually operated  
12 shutoff valve 46.

13 The operation of the embodiment of Fig. 2  
14 is the same as that of Fig. 1 with respect to normal  
15 raise and lower operations. Likewise, the operation  
16 of the ride control system 40 operates in the same  
17 manner. The only difference between the operation of  
18 the two embodiments is that during the raise mode  
19 with the ride control de-activated, the raise mode  
20 command is directed through the electrically actuated  
21 switching valve 68 to both the first valve  
22 arrangement 47 and the two position valve 52 of the  
23 second valve arrangement 50. The raise mode command  
24 moves the two position valve 52 to its flow passing  
25 position so that the pressure in the raise ports 18  
26 is connected to the accumulator arrangement 42 thus  
27 equalizing the pressures therebetween. At the same  
28 time, the raise mode command moves the first valve  
29 arrangement 47 towards its flow passing position in  
30 proportion to the magnitude of the raise mode  
31 command. This permits the flow from the lower ports

1       20 to controllably pass to the reservoir 23  
2       thereacross. The remainder of the operation is the  
3       same as that with respect to Fig. 1.

4              The operation of the embodiment of Fig. 3  
5       is the same as that with respect to Fig. 1 with the  
6       exception that the manually operated shutoff valve 46  
7       has been replaced with the two position bypass valve  
8       74. During normal operation with either the source  
9       of pressurized fluid or the source of pressurized  
10      pilot fluid operational, the two position bypass  
11      valve 74 is maintained in its flow blocking position.  
12      It is recognized that either of the sources of  
13      pressurized fluid could be solely connected to the  
14      bypass valve 74. If the machine becomes disabled so  
15      that the associated source of pressurized fluid 22/30  
16      is not producing fluid flow, the bypass valve 74 is  
17      mechanically urged to its flow passing position thus  
18      connecting the accumulator arrangement 42 with the  
19      reservoir 23.

20             The operation of the embodiment of Fig. 4  
21      is the same for normal operation and operation of  
22      ride control as that with respect to Fig. 1. The  
23      major difference in the operation of the embodiment  
24      of Fig. 4 is in balancing the pressure in the  
25      accumulator arrangement 42 with respect to the  
26      pressure in the raise ports 18. In the embodiment of  
27      Fig. 4, in the event the load is lessened by removing  
28      a portion of the load, the pressure in the raise  
29      ports 18 is likewise lowered. If the raise ports 18  
30      were connected to the accumulator arrangement 42  
31      under these conditions, as in Figs. 1-3, the load

1 would slightly move upward until the pressures are  
2 equalized. But in Fig. 4, with the pressure in the  
3 raise ports 18 at a lower level than that of the  
4 pressure in the accumulator arrangement 42, the  
5 difference in the respective pressures acting on the  
6 proportionally controlled two position valve 82 moves  
7 the proportionally controlled two position valve 82  
8 towards its flow passing position thus bleeding off  
9 pressurized flow from the accumulator arrangement 42  
10 through the conduit 84 to the reservoir 23. Once the  
11 respective pressures in the raise ports 18 and the  
12 accumulator arrangement 42 are again balanced the  
13 proportional valve 82 returns towards its flow  
14 blocking position to maintain the pressure balance  
15 therebetween.

16 The operation of Fig. 5 is similar for  
17 normal operation and operation of ride control as  
18 that with respect to Fig. 1. The operation of the  
19 proportionally controlled two position valve 82 is  
20 the same as that with respect to Fig. 4. However, in  
21 the operation of the embodiment of Fig. 5, the two  
22 position blocker valve 94 prohibits the flow from the  
23 proportionally controlled two position valve 82 to  
24 pass therethrough when the system is being operated  
25 with the ride control mode de-activated.  
26 Consequently, if the load has been lessened during  
27 normal operation, the pressure in the accumulator  
28 arrangement 42 is maintained higher than that in the  
29 raise ports 18. Once the ride control mode is  
30 activated, the two position blocker valve 94 is moved  
31 to its flow passing position.

1           In order to provide a slight time delay  
2 between activating the ride control mode which moves  
3 the blocker valve 94 to its flow passing position and  
4 the opening of the two position valve 52 of the  
5 second valve arrangement 50, the choke and check  
6 valve arrangement 92 is disposed in the signal  
7 conduit 49 downstream of the connection with the  
8 blocker valve 94 and upstream of the connection with  
9 the first and second valve arrangements 47, 50. Since  
10 the ride control mode command to the first and second  
11 valve arrangements is choked/restricted, the bypass  
12 valve 94 opens first to permit pressure balancing  
13 between the raise ports 18 and the accumulator  
14 arrangement 42 prior to the raise ports 18 being  
15 placed in communication with the accumulator  
16 arrangement 42 across the two position valve 52.

17           The addition of the pilot operated check  
18 valve 98 adjacent the two position valve 52 operates  
19 to permit holding of a higher pressure in the  
20 accumulator arrangement 42 during normal operation  
21 when the load is being raised without the ride  
22 control being activated. The use of the pilot  
23 operated check valve 98 helps extend the life of the  
24 accumulator arrangement 42. By keeping the pressure  
25 in the accumulator arrangement 42 from continuously  
26 increasing and decreasing due to normal operation,  
27 the life of the accumulator arrangement 42 is  
28 increased. Initiation of the ride control mode  
29 command directs a signal to the pilot operated check  
30 valve 98 moving it to its open position thus

1 permitting free flow between the raise ports 18 and  
2 the accumulator arrangement 42.

3 The operation of the embodiment of Fig. 6  
4 is the same as that for Fig. 5 during normal  
5 operation and during the ride control mode of  
6 operation. The flow restriction mechanism 56 of Fig.  
7 6 is a single proportional valve 102 that is  
8 operative to provide the functions of the flow  
9 restriction mechanism 56 and the two position bypass  
10 valve 74 of Fig. 5. The pressures of the fluid in  
11 the accumulator arrangement 42 and the raise ports 18  
12 are equalized by the pressure relationship of the  
13 respective pressures being directed to the  
14 proportional valve 102 and controllably venting a  
15 portion of the pressure in the accumulator  
16 arrangement 42 if the load is lessened. Since the  
17 pressure of the source of pressurized pilot fluid 30  
18 is acting on the proportional valve 102 urging it to  
19 its flow blocking position, the pressure balancing of  
20 the accumulator arrangement 42 and the raise ports 18  
21 cannot happen until the cushion ride mode is  
22 activated. Once the cushion ride mode is activated,  
23 the cushion ride mode command is directed to the  
24 proportional valve 102 through the conduit 96 in  
25 opposition to the force created by the source of  
26 pressurized pilot fluid 30 acting on the other end.  
27 Consequently, thereafter, the proportional valve 102  
28 can function to equalize the pressures between the  
29 raise ports 18 and the accumulator arrangement 42.

30 Likewise, since the source of pressurized  
31 pilot fluid 30 is acting on the proportional valve

1       102 urging it towards its flow blocking position and  
2       the cushion ride control mode command is acting to  
3       urge it towards the flow passing position and the  
4       ride control mode command is established by the  
5       source of pressurized pilot fluid 30, absence of the  
6       source of pressurized pilot fluid 30 permits the  
7       combined forces of the pressure of the fluid in the  
8       accumulator arrangement 42 and the mechanical biasing  
9       spring 104 to urge the proportional valve 102 to its  
10      flow passing position to bleed-off the pressure in  
11      the accumulator arrangement 42 in the event that the  
12      machine is disabled.

13           From the foregoing, it is readily apparent  
14       that the subject hydraulic ride control system 40  
15       provides a cushion ride arrangement for a machine  
16       that permits the pressure in the accumulator  
17       arrangement 42 to be equalized with the pressure of  
18       the fluid in the raise ports 18 and to permit the  
19       accumulator arrangement 42 to be bleed down in the  
20       event that the machine is disabled.

21           Other aspects, objects and advantages of  
22       the invention can be obtained from a study of the  
23       drawings, the disclosure and the appended claims.

1

Claims

2

3           1. A hydraulic ride control system  
4 adapted for use in a fluid system of a machine to  
5 cushion the ride of the machine in response to  
6 initiation of a ride control mode command, the  
7 machine having a frame with an actuator arrangement  
8 disposed between the frame and a load to raise and  
9 lower the load relative to the frame, the actuator  
10 arrangement having a raise port and a lower port, the  
11 actuator arrangement being operative upon initiation  
12 of a raise mode command to raise the load to a  
13 desired height in response to pressurized fluid being  
14 selectively directed to the raise port from a source  
15 of pressurized fluid and to exhaust fluid from the  
16 lower port to a reservoir in response to initiation  
17 of a lower mode command, the hydraulic ride control  
18 system comprising:

19           an accumulator arrangement connectable to  
20 the raise port of the actuator arrangement;

21           a first valve arrangement connectable  
22 between the lower port of the actuator arrangement  
23 and the reservoir and operative to selectively  
24 connect the lower port to the reservoir in response  
25 to initiation of a ride control mode command;

26           a second valve arrangement disposed between  
27 the accumulator arrangement and the raise port of the  
28 actuator arrangement and operative to selectively  
29 connect the accumulator arrangement to the raise port  
30 of the actuator arrangement in response to one of the

1 initiation of the raise mode command and the  
2 initiation of a ride control mode command.

3

4           2. The hydraulic ride control system of  
5 claim 1 wherein the second valve arrangement is a two  
6 position valve that is mechanically biased to a flow  
7 blocking position and movable to a flow passing  
8 position in response to one of the raise mode command  
9 and the ride control mode command.

10

11           3. The hydraulic ride control system of  
12 claim 2 wherein the second valve arrangement includes  
13 a flow restriction mechanism connectable between the  
14 accumulator arrangement and the raise port of the  
15 actuator arrangement in parallel with the two  
16 position valve.

17

18           4. The hydraulic ride control system of  
19 claim 3 wherein the flow restriction mechanism is a  
20 one way check valve which permits flow away from  
21 the accumulator arrangement towards the raise port  
22 of the actuator arrangement and prohibits reverse  
23 thereto.

24

25           5. The hydraulic ride control system of  
26 claim 3 wherein the flow restriction mechanism is a  
27 proportionally controlled two position valve that  
28 controllably directs pressurized fluid from the  
29 accumulator arrangement to the reservoir responsive  
30 to the relationship between the pressure of the fluid

1 in the accumulator arrangement and the pressure of  
2 the fluid in the raise port of the actuator  
3 arrangement.

4

5                 6. The hydraulic ride control system of  
6 claim 5 wherein the flow restriction mechanism also  
7 includes a two position blocker valve disposed  
8 between the proportionally controlled two position  
9 valve and the reservoir, the two position blocker  
10 valve is mechanically biased to a flow blocking  
11 position and movable to a flow passing position in  
12 response to initiation of the ride control mode  
13 command.

14

15                 7. The hydraulic ride control system of  
16 claim 5 or 6 wherein the proportionally controlled  
17 two position valve is also movable towards the  
18 position to direct flow from the accumulator  
19 arrangement to the reservoir in response to  
20 initiation of the ride control mode command.

21

22                 8. The hydraulic ride control system of  
23 any of claims 1 to 7 wherein the first valve  
24 arrangement is biased to a flow blocking position and  
25 selectively movable towards a flow passing position  
26 in response to one of the initiation of a raise mode  
27 command and a ride control mode command.

28

29                 9. The hydraulic ride control system of  
30 claim 8 wherein the first valve arrangement is

1 proportionally movable towards the flow passing  
2 position in response to initiation of the ride  
3 control mode command.

4

5                 10. The hydraulic ride control system  
6 of any of claims 1 to 9 wherein the accumulator  
7 arrangement is controllably vented to the  
8 reservoir.

9

10                11. The hydraulic ride control system  
11 of claim 10 wherein a manually operated control  
12 valve is disposed between the accumulator  
13 arrangement and the reservoir.

14

15                12. The hydraulic ride control system of  
16 claim 10 wherein a two position bypass valve is  
17 disposed between the accumulator arrangement and  
18 the reservoir, the two position bypass valve is  
19 mechanically biased to a flow passing position and  
20 adapted for movement to a flow blocking position in  
21 response to pressurized fluid from the source of  
22 pressurized fluid.

23

24                13. The hydraulic ride control system of  
25 claim 12 including a source of pressurized pilot  
26 fluid and wherein the two position bypass valve is  
27 movable to the flow blocking position in response to  
28 one of the source of pressurized fluid and the  
29 source of pressurized pilot fluid.

30

1               14. The hydraulic ride control system of  
2 any of claims 1 to 12 including a source of  
3 pressurized pilot fluid and wherein initiation of  
4 the ride control mode command includes an  
5 electrically actuated two position switching valve  
6 connected to the source of pressurized pilot fluid  
7 and operative to direct pressurized pilot fluid  
8 therefrom to the first and second valve arrangements  
9 in response to an electrical input signal requesting  
10 actuation of the ride control system.

11

12               15. The hydraulic ride control system  
13 of claim 14 including a choke and check valve  
14 arrangement disposed between the electrically  
15 actuated two position switching valve and the  
16 first and second valve arrangements, the choke  
17 and check valve arrangement is operative to  
18 permit free flow of fluid from the first and  
19 second valve arrangements to the electrically  
20 actuated two position switching valve and to  
21 choke or restrict the rate of flow from the  
22 electrically actuated two position switching  
23 valve towards the first and second valve  
24 arrangements.

25

26               16. The hydraulic ride control system of  
27 claim 14 or 15 including a pilot operated check  
28 valve disposed between the accumulator arrangement  
29 and the second valve arrangement and operative to  
30 prohibit flow from the accumulator arrangement to

1 the second valve arrangement in the absence of a  
2 pressure signal from the electrically actuated two  
3 position switching valve and to permit flow from  
4 the accumulator arrangement to the second valve  
5 arrangement in response to a pressure signal from  
6 the electrically actuated two position switching  
7 valve.

8

9                 17. The hydraulic ride control system  
10 of claim 16 wherein the pressure signal from the  
11 electrically actuated two position switching  
12 valve to the pilot operated check valve is  
13 delivered from a location between the  
14 electrically actuated two position switching  
15 valve and the choke and check valve arrangement.

16

17                 18. A hydraulic ride control system  
18 substantially as hereinbefore described and  
19 illustrated in the accompanying drawings.



Application No: GB 0028397.8  
Claims searched: 1 to 18

Examiner: Trevor Berry  
Date of search: 10 April 2001

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): F1P

Int Cl (Ed.7): E02F

Other: ONLINE: EPODOC, JAPIO, WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage		Relevant to claims
X	US 5733095	CATERPILLAR	at least
X	US 5513491	O & K ORENSTEIN & KOPPEL	at least
X	US 5195864	CASE	at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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